Applying proximity sensors to monitor beef cattle social behaviour as an indicator of animal welfare

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Abstract

There are currently no approved monitoring programs in the beef industry that use paddock based behaviour as an indicator of animal welfare. Current animal welfare assessments are conducted at a single point in time, such as supplying food and water and treating illnesses as these needs arise. These aspects comply with the five freedoms that animals should have when addressing animal welfare, however, the assessments are infrequent. Of the five freedoms, the freedom to express normal behaviour can be a subjective measure, due to differences in the way individual animals express certain behaviours. There is a need for continual monitoring of welfare indicators in modern animal assessment methods to objectively measure behaviour and address public concerns about the welfare state of animals.

The experiment commenced in June 2017 to assess changes in cattle social interaction patterns in response to social stress created by regrouping four groups of eight heifers. Previous research with cattle has provided evidence that social contact and spatial behaviour differ when novel individuals are introduced (Patison et al., 2010b), and re-grouped animals continue to experience stress until the social hierarchy is re-established after regrouping (Kondo and Hurnik, 1990). Proximity sensors that record the frequency and duration of close proximity contacts (<4 m) will be used to remotely collect animal association data, while blood cortisol concentrations will be used as an independent measure of stress. Responses to stress will be compared with a group of heifers where re-grouping does not occur.

This paper outlines the background and methodology to explore the potential for proximity sensors as a continual welfare monitoring device, related to an animal's freedom to express normal behaviour. Preliminary results of the project will be presented at The International Tri-Conference for Precision Agriculture held in New Zealand in October, 2017.

Background

Many consumers perceive food produced using animal welfare friendly practices to be more healthy for themselves, the animal and the environment as a whole, and are willing to pay greater price premiums as a result (Kehlbacher et al., 2012). Intensively managed food producing animal enterprises in Australia, such as those for chickens, turkeys and pigs, have the option to be accredited with the RSPCA approved farming practices, which aims to ensure welfare friendly treatment is given to animals that results in differentiated products for consumers (RSPCA, 2014). While welfare friendly practices are encouraged in the beef industry, there is no formal recognised assessment method for optimal welfare practices. Extensively managed production systems, such as those of the northern Australian beef industry, have several monitoring and welfare control challenges. With an average farm size of 23,000 ha and an average of 1,400 cattle per property (Martin, 2015), economies of scale make individual animal tracking using visual assessment nearly impossible on some properties, where animals may only be observed by caretakers once or twice a year. Automated monitoring sensors attached to animals provide a method of assessing the welfare of extensively managed livestock.

The five freedoms welfare model uses outcome-based indicators to directly assess whether individual animal's basic needs and provisions are being met (Webster, 2016). Of the five freedoms, the freedom to express normal behaviour can be a subjective measure, due to differences in the way individual animals express certain behaviours and the difficulty in assessing normal behaviour (Webster, 2016). Abnormal behaviour is an indicator that an animal's welfare is compromised, thus, knowledge of normal behaviour is required to assess welfare (Broom and Fraser, 2007). Within domesticated livestock species, Llonch et al. (2015) assigned four behavioural categories that relate to the freedom to express normal behaviour: abnormal behaviour, such as redirected behaviour and stereotypies; agonistic behaviour, such as aggression; normal behaviour, such as play and rumination; and, positive behaviours, such as affiliative behaviour. Of these behaviours, those that relate to social interactions (agonistic, affiliative and play) can provide information on both the welfare of individuals and groups, as a change in the behaviour of one individual will affect the overall social structure of the group, therefore, emphasizing the importance of social behaviour for assessing animal welfare.

Previous welfare assessments have relied on observations to record indicators of welfare, such as the provision of resources (food, water, shelter) as well as qualitative assessments of behaviour (e.g., pain indicators such as lameness). Welfare assessment methods should be valid, reliable and feasible, which can be difficult to achieve when assessments are performed without formal training because of the variation in perceptions about animal behaviour and welfare standards (Knierim and Winckler, 2009). Additionally, individual animals can differ in response to their environment, further complicating subjective welfare assessments. As an example, individual animals differ in their willingness to be close to others, with those considered more sociable expressing greater agitation when separated from the group compared with less sociable individuals (Sibbald and Hooper, 2004; Patison et al., 2010a). Animal based measures, rather than environmental measures, are considered to be the most valid for welfare assessments, as these allow for direct assessment of an animal's capacity to cope with their environment (Main et al 2007). The use of sensors attached to animals that automatically record behavioural information can provide data related to both animal based measures, such as physiological status, as well as environmental information, such as decreased pasture availability or the presence of a predator, thereby providing for a holistic welfare assessment.

Automatic data recording technologies such as GPS, accelerometers and proximity sensors provide objective data that are reliable, relatively cost effective, and overcome many of the errors encountered in recording and interpreting visually observed behaviour. Visual observations require extensive labour and training, are not continuous, necessitate observers to simultaneously identify and assess multiple animals at the same time and the presence of observers can alter the animals behaviour. In extensively managed livestock production, animals may only be observed by animal caretakers two to three times per year when animals are gathered for branding and weaning. While visual observations provide the most descriptive assessment of an individual's behaviour, these may not be the most appropriate to meet the criteria of a reliable and valid welfare assessment criteria in extensively managed livestock production enterprises. There is a need for studies that use continuous behavioural measures to identify the direct links between independent measures of stress and changes in social interactions, which will provide greater detail on welfare assessments than what has previously been achieved using visual observations.

Technologies to record behavioural data have improved and there are various devices that have been used to assess livestock welfare, either directly or indirectly. The aim of this study is to assess the use of proximity sensors (Figure 1) to record changes in association patterns caused by re-grouping. Previous studies have shown that proximity sensors can detect changes in association patterns during a breeding season (Swain et al., 2015), with the network of interactions clearly defined between pregnant cows and cows with calves (Figure 2). It is hypothesised that animals not consistently grouped with herd mates will have fewer encounters for less duration than animals consistently grouped with herd mates, due to social stress caused by re-grouping.

Study design

The study will be conducted at the Belmont Research Station (150° 13´E, 23° 8´S), 26 km north of Rockhampton, Australia. The experimental period began in May 2017 and will conclude at the end of August 2017. Belmont Red heifers (n = 40), approximately 2.5 years old and between 5-7 months pregnant at the beginning of the study, were selected from a larger herd and assigned to groups (n = 8; balanced for expected calving date) for 8 weeks prior to the start of any experimental treatments to allow the social structure of the groups to stabilise. According to Sato et al. (1990), 45 days are required for newly introduced animals to be socially integrated into a cattle herd. All procedures are approved by the CQUniversity Animal Ethics Committee (approval number 20475).

Over a series of three regrouping periods, three treatments will be imposed with three different amounts of mixing (C: no animals exchanged; M_1: one animal exchanged, or M_4: four animals exchanged), using to a 3 x 3 Latin square experimental design (Figure 3). The animals being exchanged will be sourced from the fourth treatment group, where five animals will be exchanged from this group and introduced into two of the treatment groups, either as a single animal (one animal exchanged) or as a group of four (four animals exchanged). The fourth group, therefore, will continually experience some degree of regrouping. The fifth treatment group will remain as a single group in which there is no re-grouping throughout the entire experiment, denoted as the consistent control.

Animals will be fitted with proximity sensors attached to a neck collar to record continual association data. The sensors record the date, time and duration of each encounter within approximately 1 body length of the animal (<4 m). Serum cortisol concentrations will be quantified at times when there are expected to be the greatest stress throughout the experiment, with samples taken prior to any regrouping as a baseline measurement, during the regrouping treatments, and at the end of the study. Animal-to-animal association data will be analysed per group and compared between treatments. Network diagrams will be used to visualise the social structures of each group.

Potential outcomes

The findings from this study will be used to inform potential on-farm welfare monitoring applications for beef cattle managed under extensive conditions in northern Australia. Detecting animal-to-animal association changes brought about by stress provides an opportunity to identify factors affecting individual animals, both physiological (e.g., illness) and environmental (e.g., depleted food and water, predator presence). The quantification of social associations to objectively measure cattle welfare, therefore, provides the opportunity for greater understanding of animal responses to a range of external stimuli, which will allow consumers to make more informed food choices based on knowledge regarding the welfare of cattle produced on extensive rangelands. The outcomes may also provide livestock producers with information that they can use to improve productivity.

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